

### REMARKS

Claims 1, 3, 4, 6-10, 17, 18, 23 and 27 are amended. Support for the amendments is found in the originally filed claims and throughout the specification. Specifically, support for amendments to Claim 23 is found in Example 8; support for amendments to Claim 27 is found in the data shown in Table 2. No new matter is introduced.

Claims 20-22, 24-26 and 28-29 are cancelled. Therefore, the Examiner's rejections of Claims 20-22, 24-26 and 28-29 will not be addressed.

The remainder of these remarks is set forth under appropriate subheadings for the convenience of the Examiner.

#### Rejection of Claims 1-29 Under 35 U.S.C. § 112, Second Paragraph

Claims 1-29 are rejected under 35 U.S.C. § 112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

Specifically, the Examiner stated that Claims 1, 3, 4, 6-10, 18, 20-23 and 25-29 [25, 27-29] are indefinite as to the phrase "phenol-based" because the Examiner is unclear as to what this means, thus rendering the scope of the claims unclear and that the phrase "phenol-based" has numerous interpretations, for instance, pure phenol, a material formed from reaction with phenol, etc. The Examiner stated that Claims 7, 21, 24 and 28 are indefinite and that these claims should be amended to recite wherein the method further comprises combining an organosilicon component with the abrasive grain and phenol components of step (a). The Examiner also stated that Claim 15 is indefinite because the Examiner is unclear as to what "live steam" encompasses, thus rendering the scope of the claim unclear. The Examiner stated that Claim 17 is indefinite and that the claim should be rewritten to recite that the atmosphere is in contact with the resin for a period of at least 5 hours. In addition, the Examiner pointed out grammatical inconsistencies in Claims 23 and 24. The Examiner further stated that the other claims are indefinite because they depend on indefinite claims.

Without agreeing with the Examiner that the term "phenol-based" is indefinite, Applicant has amended Claims 1, 3, 4, 6-10, 18, 23 and 27 to recite "phenolic resin" rather than "phenol-based" resin.

As suggested by the Examiner, Claim 7 has been amended. The claim now recites "wherein the method further comprises combining an organosilicon component with at least one of the abrasive grain component or the phenol-based resin component of step a)."

The meaning of the term "live steam" (Claim 15) is clearly defined in the specification. At page 10, lines 12-14 of the specification it is stated that "live steam" refers to steam from a steam source outside the curing chamber. The Examiner's attention also is directed to the description of "live steam" at page 10, line 14 through page 11, line 16 of the specification.

As suggested by the Examiner, Claim 17 has been amended. Present Claim 17 recites that the atmosphere is in contact with the molded components for a period of at least 5 hours.

In light of the amendments discussed above, and clear term definitions provided in the subject application, Claims 1-19, 23 and 27 meet the requirements of 35 U.S.C. § 112, second paragraph.

#### Applicant's Invention and Advantage of Applicant's Invention

Applicant's invention generally is related to organically bonded abrasive articles and a method for producing them. In one aspect, Applicant's claimed invention is directed to a method for producing an organically bonded abrasive article, e.g., a grinding wheel. The method includes the steps of combining an abrasive grain component and a phenol-based resin component; molding the combined components; and thermally curing the phenol-based resin component in an atmosphere comprising humidity, wherein said atmosphere contacts the molded components, thereby producing the organically bonded abrasive article.

As discussed at page 8, lines 13-24 of the subject application, an atmosphere comprising humidity refers to an atmosphere having a relative humidity (R.H.) that exceeds the normal R.H. at a given temperature. ~~As discussed in the specification,~~ molded components are heated, generally step-wise, and can be soaked at an initial temperature, e.g., about 100° C, after which they are heated to the temperature at which the phenol-based resin components harden via cross-linking polymerization reactions. As claimed, the atmosphere comprising humidity is present

during thermal curing, i.e., during polymerization (e.g., crosslinking in the presence of crosslinking agents such as hexamethylenetetramine) of the phenol-based resin component.

As shown in the working examples of the subject application, abrasive test bars and wheels produced by the method of the invention had improved properties, with respect to their percent wet strength retention and wet burst speed, when compared to control samples having the same specification that had been manufactured by a conventional process.

As discussed in the application at page 12, lines 5 through page 13, line 3, the presence of moisture during thermal curing is believed to result in a stronger interface between abrasive grain and organic bond and in increased cross-link density which, in turn, is believed to be less susceptible to attack by water. In addition, Applicant's invention reduces or minimizes the amount of detrimental byproduct ammonia trapped in the abrasive article.

Rejection of Claims 1-3, 12, 17, 18 and 20 Under 35 U.S.C. § 102(b) or Under 35 U.S.C. § 103(a)

Claims 1-3, 12, 17, 18 and 20 are rejected as anticipated by or, in the alternative, as obvious over either Rowse, *et al.*, (U.S. patent No. 3,323,885) or Australian Patent 20356/67.

The Examiner stated that each of the two references teaches a method of making a grinding wheel comprising mixing together an abrasive grain and a phenol-based binder, shaping the mixture and thermally curing the mixture in an atmosphere that comprises humidity; that the cure can be at a temperature higher than 100° C; and that the curing treatment is conducted in a container.

Rowse, *et al.*, as well as Australian Patent 20356/67, disclose a process of manufacturing phenol-formaldehyde resin bonded abrasive articles. In the manufacturing process, a mixture of abrasive and resin is heated from room temperature to an initial soaking temperature of about 100° C, followed by further heating and soaking at 175° C, to effect polymerization of the resin. The references disclose providing a humid atmosphere during the initial soaking at a temperature of about 100° C:

With respect to the temperature at which the humidity treatment takes place, obviously and as shown by our results any temperature

within 5 or 10 degrees of the boiling point of water would be effective to produce the improved results of the invention (Australian Patent 20356/67 at page 10, lines 25-29).

The humid atmosphere is produced, for example, by placing water containers or saturated salt solutions in a chamber housing the wheel mixture, or in a humidity controlled oven at 100° C.

After soaking for at least five minutes, the humid atmosphere is removed, for instance, by removing the water containers or saturated salt solutions from the chamber, removal of walls, venting or by forced air circulation. As the wheel mixture is heated to the final bake temperature of 175° C, e.g., Australian Patent 20356/67 at page 15, lines 26-31, and Rowse, *et al.* at Col. 6, lines 41-46), water vapor is effectively dissipated from the curing chamber and the polymerization (hardening) of the resin bond is performed in an atmosphere having ambient (normal) R.H. at the curing temperature. The process is described, for example, at Col. 2, lines 56-68 of Rowse, *et al.*:

The water may be provided in the wheel mixture and by evaporation from an open receptacle in a closed oven, and is present and available throughout the mass of the wheel during an initial heating step wherein the wheel temperature is raised from room temperature to about 100° C, where it is held soaking in the moistened atmosphere for a period of from five minutes to one hour or more, after which the open water receptacle is removed and the bake is completed without moisture control.

Therefore, the cited references, as discussed above, teach removal of the humid atmosphere before conducting the cure (hardening) of the resin.

The references also disclose supplying moisture by wrapping the article in a moisture impermeable membrane. As stated at Col. 4, lines 3-6 of Rowse, *et al.*:

In the case of wrapped wheels, the water originally present in the wheel mix is in most cases sufficient to completely saturate the restricted atmosphere surrounding the wheel when subjected to a temperature of 100° C.

Above the boiling point of water, water vapor dissipates, the moisture impermeable membrane being loosely wrapped to allow relief of pressure build-up. (See, for example, Rowse, *et al.* at Col. 4, lines 1-3 or Claim 8.)

There is no disclosure or suggestion in Rowse, *et al.* or in Australian Patent 20356/67 regarding controlling or maintaining the atmosphere's moisture content above the boiling point of water. Neither Rowse, *et al.* nor Australian Patent 20356/67 disclose or suggest thermal curing, i.e., polymerization, of the phenol based component in an atmosphere comprising humidity, i.e., an atmosphere having a R.H. that exceeds the normal humidity at the curing temperature.

Furthermore, there is no recognition or appreciation in the cited references regarding advantages provided by the presence of water during crosslinking, as discussed, for instance, at page 12, lines 17-19 of the subject application.

Nor do the cited references provide motivation or incentive for supplying an atmosphere comprising humidity during the thermal cure of the resin. See, for example, Col. 11, lines 15-21 of Rowse, *et al.*, where it is stated:

Wheels bonded with one-stage phenol formaldehyde resin were improved as well as two-stage phenol formaldehyde bonded wheels by supply a moist atmosphere during the early part of the cure cycle with little apparent advantage as a consequence of prolonging the retention of a humid atmosphere beyond 115° C. oven temperature.

Thus, neither Rowse, *et al.* nor Australian Patent 20356/67 disclose, suggest or provide motivation for a method for producing an organically bonded abrasive article that includes the steps of combining an abrasive grain component and a phenol-based resin component; molding the combined components; and thermally curing the phenol-based resin component in an atmosphere comprising humidity, wherein said atmosphere contacts the molded components, thereby producing the organically bonded abrasive article.

Therefore Claims 1-3, 12, 17 and 18 meet the requirements of 35 U.S.C. § 102(b) and 35 U.S.C. § 103(a) in view of Rowse, *et al.* and Australian Patent 20356/67.

Rejection of Claims 4-11, 14-16 and 21-29 Under 35 U.S.C. § 103(a)

Claims 4-11, 14-16 and 21-29 are rejected under 35 U.S.C. § 103(a) as obvious over either Rowse, *et al.* or Australian Patent 20356/67, both in view of Colleselli (U.S. Patent No. 4,381,925).

The Examiner stated that Colleselli teaches a grinding disk (wheel) that comprises an abrasive grain, a phenolic binder and an organosilicon material, wherein the organosilicon material coats the abrasive grain and that the organosilicon material improves the bonding between the abrasive grain and the bonding agent. The Examiner also stated that the primary references use phenol formaldehyde resin, in general, and this broadly encompasses phenol formaldehyde resins having any phenol formaldehyde ratio and that this resin encompasses and therefore makes obvious novolac and resole resin. The Examiner stated that one skilled in the art would have found it obvious to add an organosilicon component to the method of the primary references because the use of this component (as a coating on the abrasive, as defined, by the secondary reference) improves the adhesion (bond strength) between the abrasive and the bond (phenolic bond) and that the strength retention of the bond is improved. The Examiner stated that motivation for the use of this component is in the fact that the secondary reference teaches that this component improves the bond between the abrasive and the bonding agent in bonded abrasives. With respect to the use of both powdered and liquid resins (Claim 9), the examiner stated that one skilled in the art would have found it obvious to use any form (powder or liquid) of the resin, as long as the final bonding agent is said resin. The Examiner further stated that the mode of addition is considered to be an obvious variation of the references mode of addition in the absence of any evidence showing criticality. With respect to the use of steam, the Examiner stated that since the references use a humid atmosphere, the use of any type of humid atmosphere is well within the level of ordinary skill in the art and that, since steam is a well known humid atmosphere, its use as the atmosphere according to the primary references is obvious and well within the level of ordinary skill in the art in the absence of any evidence showing criticality.

With respect to the product claims, the Examiner stated that no distinction was seen to exist because Applicant uses process limitations to define the product and "product-by-process" claims do not patentably distinguish the product even though made by a different process. With

respect to the strength retention, the Examiner stated that since the compositions are the same, (contains all of the claimed components), the strength retention will also be the same (within the claimed range) because the same article is expected to have the same properties in the absence of any evidence showing the contrary. With respect to the organosilicon component, this is obvious for the reasons defined above.

As discussed above, neither Rowse, *et al.* nor Australian Patent 20356/67 discloses or suggests thermal curing the phenol-based resin component in an atmosphere comprising humidity, wherein the atmosphere contacts the molded components, thereby producing the organically bonded abrasive article.

Colleselli is directed to abrasive articles that include abrasive grain, organic bond and an active filler, e.g., graphite. The reference generally discloses possible coating with silanes.

Colleselli does not remedy the deficiencies of Rowse, *et al.* or Australian Patent 20356/67. As with Rowse, *et al.* and Australian Patent 20356/67, there is no disclosure or suggestion in Colleselli regarding thermal curing of the organic bond in an atmosphere comprising humidity.

Thus none of the references cited, alone or in combination, teaches or suggests a method for producing an organically bonded abrasive article that includes the steps of combining an abrasive grain component and a phenol-based resin component; molding the combined components; and thermally curing the phenol-based resin component in an atmosphere comprising humidity, wherein said atmosphere contacts the molded components, thereby producing the organically bonded abrasive article.

As amended, Claims 23 and 27 are directed to a product produced by a process including the steps of combining an abrasive grain component and an organosilicon component to form an organosilicon-treated abrasive grain component; combining the organosilicon-treated abrasive grain component with a phenol-based resin component; molding the combined components to form a green body; and thermally curing the phenol-based resin component, in an atmosphere comprising humidity, wherein said atmosphere contacts the green body, thereby producing the product. The abrasive wheel product of Claim 23 has at least a 9 percent improvement in burst speed with respect to a standard wheel of the same specification as the abrasive wheel, while the grinding wheel product of Claim 27 has a percent wet strength retention of at least about 89.9.

As described in Example 8, the claimed abrasive wheel has a wet burst speed that is about 9 percent greater than the wet burst speed of a standard wheel having the same specification. (See Table at page 36 of the subject application). The standard products employed in Example 8 were prepared according to the teachings of Rowse, *et al.*, by a process in which thermal curing is not conducted in an atmosphere comprising humidity.

As shown in the working examples of the subject application, the percent wet strength retention of Applicant's claimed product is about twice as high as that of eleven control samples, having the same composition, yet produced by the method of Rowse, *et al.* The Examiner's attention is directed to the percent wet strength retention data regarding the eleven control samples which are presented in Table 1 (Example 1); data regarding percent wet strength retention of samples of the invention are presented in Tables 2 and 3.

Colleselli does not remedy the deficiencies of Rowse, *et al.* or Australian Patent 20356/67 with respect to Claims 23 and 27, as the reference neither recognizes, nor addresses grinding under wet conditions and provides no teaching or suggestion regarding a grinding wheel having the percent wet strength retention claimed by Applicant. Nor does the reference disclose or suggest thermal curing in the presence of an atmosphere comprising humidity.

Therefore, Claims 4-11, 14-16, 23 and 27 meet the requirements of 35 U.S.C. 103(a) over either Rowse, *et al.* or Australian Patent 20356/67 both in view of Colleselli.

#### Rejection of Claims 23-29 Under 35 U.S.C. § 103(a)

Claims 23-29 are rejected under 35 U.S.C. 103(a) as obvious over either Kunz, *et al.* or Colleselli.

The Examiner stated that the references teach grinding wheels that comprise all of the claimed components and although the claimed process is not defined, Applicant's use process limitations to define the product and "product-by-process" claims do not patentably distinguish the product even though made by a different process. With respect to the strength retention, the Examiner stated that since the composition is the same, (contains all of the claimed components), the strength retention will also be the same (within the claimed range) because the same article is expected to have the same properties in the absence of any evidence showing the contrary.



In addition, the Examiner acknowledged the tables in the instant specification but these are insufficient to show patentability because all of the examples include an organosilicon material, which is not defined by the independent claims and stated that these tables might show unexpected evidence for abrasives articles that contain an organosilicon component, but not the article claims that do not contain this component (independent article claims).

In contrast to the facts of *In re Thorpe* 227 USPQ 964 (Fed. Cir. 1985), cited by the Examiner in the Office Action, Applicant's claimed wheel is not solely defined by the process of its production. As presently claimed, Applicant's wheel also has at least a 9 percent improvement in wet burst speed with respect to a standard wheel of the same specification as the abrasive wheel (Claim 23) or a percent wet strength retention of at least about 89.9 (Claim 27).

Kunz, *et al.* disclose coating abrasive grain with silicon dioxide, for example, by mixing untreated abrasive grain with hydrophobic silicic acid. At Column 1, lines 26 through 53, Kunz, *et al.* discuss disadvantages of silane treatment of abrasive grain. Percent wet strength retention of wheels disclosed in the cited reference can be calculated (wet strength divided by dry strength X 100) from data presented in Table 2. For the convenience of the Examiner, Table 2 Kuntz, *et al.*, is reproduced below; percent wet strength retention values, as calculated by Applicant from the data in Table 2, are added beneath the original data for Lot 1 and Lot 2 and are italicized.

TABLE 2

Bending strengths (in N/cm <sup>2</sup> of the corundum grain sizes according to Example 4 (mean values and ranges of dispersion))				
Grain/Conditions	Untreated	According to the invention, Example 1	Silanized Example 2	According to the invention and silanized
<u>Lot 1</u>				
Dry	3510 $\pm$ 130	4350 $\pm$ 150	3550 $\pm$ 100	4370 $\pm$ 120
Wet	2340 $\pm$ 100	2980 $\pm$ 250	2315 $\pm$ 150	3240 $\pm$ 140
Calc. % Wet Strength Retention	66.7 %	68.5 %	65.2 %	74.1 %
<u>Lot 2</u>				
Dry	3890 $\pm$ 260	4800 $\pm$ 190	4010 $\pm$ 130	4480 $\pm$ 190
Wet	1970 $\pm$ 150	2330 $\pm$ 330	2160 $\pm$ 170	3350 $\pm$ 230
Calc. % Wet Strength Retention	50.1 %	48.5 %	53.9 %	74.8 %

Kunz, *et al.* neither disclose, nor suggest Applicant's claimed product. More specifically, the reference provides no disclosure or suggestion regarding curing in an atmosphere that comprises humidity, nor regarding a wheel having a wet percent strength retention or a wet burst speed as presently claimed by Applicant.

The highest expected improvement in wheel percent wet strength retention properties with respect to control samples, based on the teachings of Kuntz, *et al.*, is seen with data for test bars produced according to the invention and silanized (Table 2, data column 4) in comparison to the data for control test bars produced using silanized grain (Table 2, data column 3). Specifically, percent wet strength retention, calculated from the values given in Table 2 indicate that, for Lot 1, the percent wet strength retention was increased from 65.2% (silanization alone)

to 74.1% (hydrophobic silicilic acid and silanization); for Lot 2, the percent wet strength retention was increased from 53.9% (silanization alone) to 74.8% (hydrophobic silicilic acid and silanization). Moreover, a very slight improvement (Lot 1) or no improvement (Lot 2) occurred when percent wet retention values from the first (untreated) and second (according to the invention) data columns of Table 2 are compared.

In contrast, Applicant's claimed product has unexpectedly improved characteristics. As noted above and as discussed at page 12, lines 5-12 of the subject application, the presence of water during the thermal cure is believed to improve the interface between the abrasive grain and the phenolic resin and to influence reactions that take place during the thermal cure, resulting in a product that is less susceptible to attack by water. As demonstrated in the working examples, for instance in Tables 2 and 3 of the specification, abrasive samples according to Applicant's invention exhibited an approximately two-fold increase in percent wet strength retention with respect to control samples. For instance, in Table 3, Specimens #1A and #1B had a percent wet strength retention of 98.0 and 90.5, respectively, while the average percent wet strength retention of 11 control samples was 42.4, with a range (from Table 1) between 33.3 and 53.1.

Applicant's humidity cure sample performance data demonstrates better grain bonding that can only be explained by differences in the post-cure resin composition since no other coating or additive was used. In short, Applicant's resin bond differs from the resin bond of Kunz, *et al.* in a way that materially affects performance of the grinding wheel.

Colleselli generally discloses the possible coating abrasive grains with silane.

As with Kunz, *et al.*, Colleselli does not disclose or suggest curing in an atmosphere comprising humidity. Nor does the reference disclose or suggest a grinding wheel having a percent wet strength retention greater than 89.9, nor a 9 percent wet burst speed improvement over a standard wheel, as is claimed by Applicant. Moreover, there is no recognition in Colleselli of problems encountered with organically bonded abrasive tools under wet grinding conditions.

Therefore, Claims 23 and 27 meet the requirements of 35 U.S.C. 103(a), in view of either Kunz, *et al.* or Colleselli.

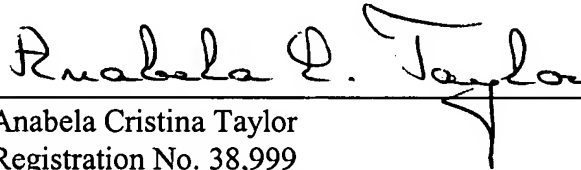
SUMMARY AND CONCLUSIONS

Applicant has amended Claims 1, 3, 4, 6-10, 17, 18, 23 and 27 and cancelled Claims 20-22, 24-26, 28 and 29. Claims 1-19, 23 and 27 meet the requirements of 35 U.S.C. 102(b) or of 35 U.S.C. 103(a) in view of the references cited by the Examiner.

In view of the above amendments and remarks, it is believed that all claims are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned at (978) 341-0036.

Respectfully submitted,

HAMILTON, BROOK, SMITH & REYNOLDS, P.C.



Anabela Cristina Taylor  
Registration No. 38,999  
Telephone: (978) 341-0036  
Facsimile: (978) 341-0136

Concord, MA 01742-9133

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